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EDITORIAL DEPARTMENT NOTE

Wage incentive plans based on adequate time and motion study will become of increased importance with the return of competitive business after the war. Unless high wages are accompanied by high productivity, costs and selling prices will be too high to encourage the volume of production necessary to provide the jobs for those willing and able to work. Soundly conceived and administered incentive plans, together with improved methods based on motion study, will be needed to reconcile the two requisites of a sound economy—high wages and low costs. Industrial accountants will play an important part in the development, installation, and operation of incentive plans based on time and motion study, and the two articles in this issue of the *Bulletin* should aid them in getting started on this important task.

Our first article is by Clayton J. Reed, who has been associated with the Kirsch Co. of Sturgis, Mich., for the past 15 years. The first 6 of these years were spent in the production department where he learned first hand the problems of labor cost control. During the past 9 years, Mr. Reed has held the position of Chief Cost Accountant for his company. Trained at the International Business College and the International Accountants Society, he has devoted a great deal of time and effort to a study of labor incentive plans. Mr. Reed is a charter member of the South Bend Chapter.

W. R. Williams, the author of our second article, is an engineer who has specialized in production control and factory management. A graduate of Marquette University in Engineering, Mr. Williams has spent many years in the textile, garment, and other fields with the Holeproof Hosiery Co., Reliance Manufacturing Co., Vanity Fair Hosiery Mills, and Sears Roebuck & Co. At present he is General Factory Manager of Haggar Co. in Dallas.

Articles published in the *Bulletin* present many different viewpoints. In publishing them the Association is not sponsoring the view expressed, but is endeavoring to provide for its members material which will be helpful and stimulating. Constructive comments are welcomed and will be published in the Forum Section of the *Bulletin*.

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APRIL 15, 1944

INCENTIVE PAYMENT PLANS—A CURRENT RESUMÉ

By Clayton J. Reed, Chief Cost Accountant,
Kirsch Company, Sturgis, Mich.

AT NO TIME in the history of the United States has there been such a dramatic need for maximum production on the part of our industrial workers. And probably also, there has never before existed the high degree of suspicion that these same industrial employees are performing far, far below their maximum degree of efficiency. There are commendable exceptions, of course, but on the whole, it appears that substantial improvement is an urgent need in an economy devoted to the all-out prosecution of a highly mechanized war.

Much has been said and written regarding the problem; innumerable solutions have been proffered. Foremost—and advocated by many high government officials and industrial leaders—has been the principle of wage incentives. It shall be my endeavor, in the paragraphs that follow, to present the major aspects of such plans and their installation, and in conclusion, to outline the plan which we, in the Kirsch Company, have adopted with, we feel, very satisfactory results, both from production and cost reduction standpoints.

Primary Aspects

The adoption of an adequate wage incentive plan must be preceded by important preliminary measures: shop conditions should be improved and standardized; the various operations performed should be studied in detail; the most suitable group of motions learned; and the employees instructed in the best ways of performing the operations.

Difficulties which have resulted because of incentive systems being installed without standard times being accurately determined by motion economy analysis and without the operator being properly trained, are many. It is *so* easy to guess a rate and find out later that it is "loose." It is *not* easy to make an employee happy after you have cut his rate—this after he has shown an increased production, with an inevitable burden saving, and by so doing, proved that the time study was incorrect.

Job Evaluation

No matter what type of wage incentive system is used, or how carefully time standards are set, the system is likely to prove unsatisfactory if the different jobs in the plant are not carefully rated in relation to each other and all workers paid according to their relative worth. Job rating should be applied whether or not an incentive system is used.

In plants where job evaluation has been neglected, there may exist inequalities in the wages paid workers. The reasons for these conditions are not difficult to understand. Some supervisors are more aggressive than others and more concerned with furthering the interests of their workers. If the company has no plan of evaluating jobs, wages in the departments of some supervisors will be higher than in other departments. Likewise, within a department the more aggressive men will obtain rates above their less aggressive fellows.

Workers of no particular ability who remain a long time with a company are likely to receive raises occasionally, and in time will be paid out of proportion to their worth, seniority being their only claim to the high wages received. The wages paid employees should correspond to their value to the company. Inequalities cause jealousy and dissatisfaction and make it difficult to maintain satisfactory labor relations.

The first step in a well-balanced payroll plan being job evaluation, it becomes necessary to have a survey made of all jobs in the plant for the purpose of classifying the jobs into broad classes, each class consisting of jobs having approximately the same value to the company. The procedure required to make such a job classification may be summarized as follows:

1. Jobs in each department must be defined or described.
2. The factors considered of importance in determining the relative value of jobs must be selected.
3. The relative importance or weight of these factors must be determined, and point values assigned to each for convenience in rating.
4. Each job must be analyzed to determine the relative degree to which the factors selected are present in the job and to assign point values or ratings to these factors.

5. Jobs must be classified into groups containing the same range of rating points.

Motion Economy

No matter what type of wage incentive system or plan is used, nor how carefully time standards are set, the system is likely to prove unsatisfactory if the different jobs in the plant are not carefully studied. The following questions must be considered:

1. Can the operation be eliminated?
2. Can the operation be combined with another operation?
3. If the operation is a machine operation, are the feeds and speeds and tools correct?
4. What laws of motion economy are violated?

The purpose of motion economy study of a job is to save the expenditure of unnecessary human effort in accomplishing a result. Motion economy points out the simplest, fastest, and easiest way of accomplishing a given task by a scientific approach, and thus achieves its purpose by keeping the expenditure of human energy and time to a minimum.

Everyone in the manufacturing division should be familiar with the principles of motion economy because any employee who has become familiar with the principles and starts measuring his operations in comparison with good motion economy practice is very apt to be able to suggest improvements. Motion economy is not a program for a few time-study men but a plant-wide project to teach each employee the proper way to work. The application of the principles of motion economy improves industrial relations. An understanding of these principles increases the ability of foremen to teach and assist workers and thus tends to eliminate "driving" methods. If disputes resulting from changes in standard times are removed and if part of the saving resulting from motion economy is paid the employee in the form of increased wages, the morale of the workers will be improved. Better relations between management and the men will result from a better and more complete understanding of all jobs within a plant.

Time Study

We have now reveiwed briefly, first, job evaluation or base rate pay, and secondly, motion economy, where we study and

analyze the job with the view of finding the fastest and easiest way of accomplishing the task. We are now going to consider the third element necessary for a successful labor incentive system, namely, good time study.

Before attempting to keep a system of accounts a person should be thoroughly trained in bookkeeping and accounting; if he is not trained and fails, the *system* is not blamed but the untrained bookkeeper is. There is no law to prevent an unskilled man from purchasing a set of surgeon's instruments; yet one shudders to think of the result if he attempted delicate surgery. By the same token, there is no rule that prevents an untrained person from using a stop watch, although his use of it in industry is probably as dangerous as giving a loaded pistol to a child.

The American worker receives higher wages than the worker in any other part of the world; consequently, the output per man must be very high. No man objects to a full day's work if paid for it. This full day's work should be found through time study. The pay should be determined from a wage-payment or incentive plan designed to meet the requirements of each particular company or task. I believe that the great gains that labor has enjoyed in this country have come because we are not afraid to change methods and ways even if our forefathers did the job with hand tools in an old-fashioned way.

Time study must not be a secret document confined to the use of plant management. It is an accurate grouping of data that covers the best and most efficient manner of completing a job under given conditions. It becomes a set of instructions used by the foremen and by employees in arriving at ideal conditions in the pursuit of their duties. Only persons having skill, training, and thorough ability should attempt time study. Its success yields wonderful results, while its failure causes heartaches beyond words.

Day-Wage Method

The day wage is paid for *time*, with little relation between a day's accomplishment and a day's pay. Lacking any definition of what a day's work should be, the worker does just enough to keep the foreman satisfied, and no more. The foreman has no means of determining whether or not the production of his department

is up to standard; supervision is by guess, memory, and rule of thumb. Day work thus lowers the morale of the workman. He thinks that he wants to work day work but no company can afford to pay a man the same wages for day-work as for piece work or under an incentive system. The worker is not enlivened by zestful desire or ambitious drive; daily life becomes a treadmill, and in many instances the worker is bored by his own soldiering. He feels little satisfaction with his day's accomplishment, or lack thereof.

Piece-Rate Wages

Under piece work a specific sum of money is paid for each piece the worker produces. It *does* furnish a strong incentive to output. The setting of piece-rate wages would appear a simple and straight-forward matter; however, the history of modern industry is filled with innumerable instances of labor unrest from the employment of the piece-rate system. Many of the difficulties are caused by piece rates being set inaccurately.

Piece-rate systems came into use long before time-study methods were developed. The result was that many piece rates were set according to the foreman's guesses or the time previously required under day work or some other equally untrustworthy method. If the rates were too high, a worker could earn much more than the management felt the operation warranted. The rate would then be cut and this caused employee dissatisfaction. The natural result of rate-cutting was that the worker came to distrust the piece-rate system and to regard it as a means of making them speed up, without, in the long run, giving them any corresponding benefit. As a consequence they openly opposed piece rate or covertly endeavored to beat the system. It became the accepted practice among workers to discover how much management considered they should earn and then, if working on jobs with easy rates, to deliberately set their pace so as not to earn in excess of this amount. Such a practice, of course, defeats the purpose of an incentive system.

Furthermore, since piece rates are based on a given amount of money per piece, increases or decreases in the rate of pay make it necessary to change all the rates, a very troublesome job.

Differential Piece-Rate Plans

Frederick Taylor, who has been called the "Father of Scientific Management," devoted most of his life to perfecting a pay incentive method. He realized that the production technique of his day was inefficient, and he evolved a system for its improvement.

The Taylor differential piece-rate plan, introduced in 1895, corrected some of the basic flaws in the old piece-rate plan and very largely established the fundamentals of our modern wage incentive systems. It was a tremendous stride toward enlightened employer-employee relations.

Mr. Taylor set tasks within the capacity of competent workers and arranged working conditions so that such workers could accomplish their tasks. Thus the efficient worker had an opportunity to earn higher wages, but the worker who failed to perform his task was severely penalized by the differential rate feature. An example: A worker paid 7½ cents per piece if he produced less than the standard quantity per day might be paid 10 cents per piece if he produced the standard quantity, or more.

No daily wage was guaranteed. Mr. Taylor's plan embraced two piece rates: a high rate was applied to all production when the worker equalled or exceeded his task; a low rate was applied to all production when he failed to equal his task.

The improved methods and controls developed by Mr. Taylor were in themselves a strong incentive, but his plan did not achieve wide popularity; in fact, Mr. Taylor himself eventually abandoned it in favor of the plan developed by H. L. Gantt, an associate, who later became an independent consultant. He also believed that a worker should receive a high reward for performing an operation in standard time or less, and that the slow worker should be penalized. The Gantt task and bonus plan provides for two different hourly rates: a high, and a low. The low hourly rate was usually three-fourths of the high rate. The worker's low rate was the guaranteed rate. If the worker performed his operations in standard time or less he was paid for the standard time allowed for performing his operation at the high hourly rate. One advantage of this system was that rates were set in terms of time and not the variable money.

One Hundred Per Cent Premium Wage System

When this system is used, the worker is guaranteed an hourly or base rate. A standard amount of production is established and if the worker's output in any period is above the standard quantity, he is paid a premium or bonus. The standard production is stated in minutes or hours and the bonus the worker receives is the total value of the time he saves, calculated at the guaranteed hourly, or base rate. The advantages of the system are that the standards or rates are set in terms of time instead of in dollars and cents.

If the wages paid workers must be altered because of rising or falling prices, there is no need to change the standard time established for operations; only the guaranteed hourly rate must be altered. This makes it possible for wages to be changed without thousands of piece rates being altered, and means a substantial saving in clerical cost. Further, if wages must be reduced because of falling prices, the situation can be more easily explained to the workers, for, since the standard times established for the operations are not altered, it is evident that no attempt is being made to speed up production. Another advantage is that earnings are easily computed, and the worker can readily determine what his pay should be.

Measured Day-Work System

Measured day-work is a wage system under which the worker is paid by the hour or day and not according to the number of pieces produced or the number of operations performed. Provision is made, however, for measuring the performance of each worker. Standard times are established for every job or operation and a worker's production is stated in terms of standard time.

Daily and weekly departmental reports are prepared, showing the actual time required and the standard hours produced by each employee. Such reports enable the foreman to determine the efficiency of each worker in his group and to take immediate steps to remedy below-standard production. Copies of these reports are sent to the personnel department where they are filed for future reference. Reports showing the total actual and standard hours for each department are sent to the higher plant executives

and provide them with information regarding the efficiency of each foreman.

An outstanding feature of the measured day-work plan is the periodical rating of each worker as to his ability to learn, the quality of his work, his production, and his capacity for improvement—these, and others, being measured.

Ratings are made by the foreman, usually at three-month intervals, on a merit rating basis. Jobs in the plant are set within certain wage brackets with a high and a low rate for each bracket. Adjustments are made periodically to provide for increased or decreased efficiency on the part of the worker, and if the employee, by virtue of the merit rating sheet results deserves an increase, this may be done within the bracket range of the job he is performing. However, if the worker is receiving the highest pay within the bracket range, he should be considered for promotion, since this is the only way in which he can be further increased.

The measured day-work system has the following advantages:

1. It is probably more acceptable to union leaders than any other system except time wages, because under it the earnings of workers are not directly dependent upon output.
2. Since it requires scientific time and motion studies and provides an efficient means of controlling operations, it will also be more acceptable to those industrialists who believe that better results can be obtained by improving shop conditions and operating techniques and by introducing better methods of control than by installing an incentive wage system.
3. Under measured day work, operators and foremen will not resist improvements in methods since (a) their wages will not decrease when these improvements result in a temporary reduction in output, and (b) their wages are adjusted at regular intervals and the adjustment is based in part on output.
4. Measured day work will improve labor relations since it gives workers an opportunity to increase their earnings through developing the qualities of cooperation, loyalty, dependableness, etc. It is particularly applicable in highly

mechanized plants where the rate of production is relatively fixed and incentive wage systems are useless.

The measured day-work system is going to come more and more to the front in the post-war days. It provides an incentive by measuring production on individual workers and departments. Every one of us feels a stewardship responsibility for accomplishing our task on standard time and more especially when we know that the management has adequate records of our performance.

The Kirsch Company Plan

The system under which we are operating today originally was installed by Bedaux in 1934, and we have profited by the principles set out by them. However, the methods of application have been altered to meet our own specific requirements.

The Bedaux system is one of the best known point wage plans. Under this wage system, standard times are set for all operations. A worker's production is expressed as so many minutes. A worker just equals standard performance if his output is sixty minutes per hour, that is, sixty standard minutes of performance for each hour actually worked. However, it is usual practice to set standard times so that an average good worker can produce about eighty minutes work per hour. A worker producing at this rate is said to be operating at an 80 B-hour.

If the operator should work on several different operations in the same day, there is no difficulty in computing his wages since his total production is stated in minutes. Workers are paid 100 per cent of the value of excess minutes produced.

An analysis is made daily for each department showing the B-hour (or minute hour) performance for each operator for the previous day. This enables the foreman to keep a constant check on the performance of his men. It is also expected to incite a spirit of competition between operators, and to keep them interested in high output. The standard minute value is of particular importance in setting up standard costs, and is valuable to management because it gives them a measure of each employee's productive ability.

We allow a term called "process allowance minutes" to operators operating under an 80 B-hour. Process allowance minutes

are set up on a decreasing scale. From 60 to 80 minutes the scale is ½ minute for each full minute of production below an 80 minute B-hour. Below a 60 minute B-hour ten minutes is also allowed. This process allowance minutes per hour, plus the net standard hour, equals the pay standard hour. In our particular plant, the process allowance was set up by Bedaux because of the many changes and variances in standard times set, due to the nature of the product and the work.

The goal of production for every one is an 80 B-hour, or more, and in normal times and under normal conditions this goal is attainable.

Summary.

Between 1895 when Frederick W. Taylor first introduced his differential piece-rate system and the present war period many types of wage-payment plans were developed. For awhile there was quite a fad for complicated incentive systems, many of which later proved unwieldy or otherwise unsatisfactory. More recently the tendency has been toward simpler systems.

We must recognize that the key to good wage payment is accurate knowledge of what constitutes good performance, or a fair task, rather than an intricate formula for paying for that performance.

What the employee has to sell is his time and the sacrifice he makes in fatigue, risk, and boredom. What the employer wants to buy is results rather than time. Therefore, choose with great care from well-trained and experienced men your leaders for the installation of an incentive system. Formulate a complete program and train the supervisory staff of foremen and all other factory executives first. Be sure they understand, believe in, and support the incentive system you are installing before going a step further.

Then have the time-study man write all elements studied on each job on instruction cards and keep them available for the employees on the foreman's desk. Establish a well-balanced base rate. Apply motion economy analysis. Train and instruct the operators. These constitute the necessary steps in the installation of such a system.

Should you decide in February to set up a labor incentive system and try to have it installed before you plant your Victory garden, the probability is that your employees will pull up your system before you harvest your own garden. The only successful way to proceed in setting up a labor incentive system is by the use of careful, painstaking methods. Be sure you plant your system deep and in fertile soil.

MOTION AND TIME STUDY FOR POST-WAR PROFITS

By W. R. Williams, General Factory Manager, Haggar Company, Dallas, Texas

I BELIEVE it was George Washington who said, "In time of peace, prepare for war." I think this quotation applies in reverse order today, for undoubtedly, one of the major questions in the minds of business executives is, "What are the possibilities of operating a profitable business in post-war years?" There are many who believe that when we return to the "good old days" all our troubles will be over; however, it is most certain that they will discover that their customers will demand higher quality than ever before. People will be buying more critically; every article will be examined to see that the greatest value is being received.

Therefore, the progressive, alert, industrialist will be the one who places as his objective the idea of improving the quality of his product, lowering the cost, and planning his production so that delivery will be made at the right time. These three points can be accomplished, to a very great extent, through the proper application of a motion and time study program. This is not the only answer to the problem, but it will go a long way toward attaining the objective, for it was Frank Gilbreth, one of the originators of motion study, who said:

> There is no waste of any kind in the world that equals the waste from needless, ill-directed, and ineffective motions and the resulting unnecessary fatigue. Because of this there is no industrial opportunity that offers a richer return than the

transformation of ill-directed and ineffective motions into efficient activity.

Motion and Time Study Defined

There are many terms used in describing the analysis of manual operations and as a result there is much confusion over the value of each. Motion study, time study, work simplification, methods study, and process study are a few of those most used. Generally speaking, the term "motion study," if used in its broadest sense, will include all of these terms. In analyzing manual operations, motion study is employed first in order to revise the operation, to eliminate the waste effort or—to put it another way—to evolve ways and means whereby the worker can perform a greater service with the same effort. This is followed by the time study which is equally important and which is used to show the value of the effort put forth so that the employee will be properly compensated for his effort.

Time study also seeks to arrive at a standard rate of production which may be used as a basis for establishing accurate costs, standard prices, production control, and wage standards as a basis for some type of incentive or bonus plan.

The importance of the motion and time study department, which in broader terms might be called the standards departments, parallels that of the accounting department and to a certain degree each depends on the other in order to utilize standard costs. The standards department must provide the figures representing the standards for factory labor; the accounting department supplies, overhead, cost of materials, and the sales expense. The manufacturing costs must be broken down so that the standards department can analyze them to determine the causes of losses in operation due to the failure of some part of the manufacturing division to come up to standard.

Classification of Motions

So that we may observe an operation to see how it is done in order to improve it, we must have a basic knowledge of the classification of motions and their comparative values. Mr. Gilbreth was employed many years in industrial work and was perhaps one of the first to use the motion picture camera in the study of manual

operations. He discovered that in industry there were only seventeen fundamental motions and that all industrial operations were but the combination of these motions into cycles. The time value of a motion is generally determined by the musclar or mental reaction required to perform the motion; there are a few other factors which enter in, such as the speed of the machine or chemical process.

As most industrial operations are made up of physical movement, it is necessary that we know the comparative time value for movement of the various body members. For example, the movement of the finger requires the least amount of time, approximately 15/10,000ths of a minute; the next body member is the wrist movement which requires 17 per cent more time. The movement of the ankle requires approximately 30 per cent more time than a finger movement; the elbow and shoulder movement require approximately 67 per cent more time than a finger movement, and so on with the body movement of the hips and turning or twisting the body 180 degrees. The greater the body member, the greater the amount of time necessary for the movement of that member.

Probably the best example to illustrate the additional speed which can be acquired by using the fastest members of the body is the operation of the typewriter. The motions which an operator will use depends a great deal on the position of the elbows. If the elbows are held close to the side, the majority of the keys will be struck by moving the fingers and wrists, while the number of elbow and shoulder motions will be at a minimum. However, when the elbows are held several inches away from the operator's sides, the members used in typing will consist of about 60 per cent shoulder and elbow motions; these motions require more time. A check of different typists will reveal that, other factors being equal, the fastest ones will be those holding their elbows close to their sides.

The Twelve Principles of Motion Study

Generally speaking, there are twelve principles that must be observed when setting up or revising an operation if we are to get the greatest good from motion study. For this discussion we will not attempt to go into all twelve of these principles; however, we

will pick out a few to demonstrate their effective use. The twelve principles are as follows:

1. Confining motions to the lowest possible classification.
2. Eliminating physical motion by rearranging sequence of work elements.
3. Utilizing both hands simultaneously for productive work.
4. Eliminating "holds" and reducing the number of grasps.
5. Prepositioning tools and materials to reduce "search" and "select."
6. Use of "release load in transit" or "drop delivery."
7. Use of feet to relieve work of hands.
8. Arrangement of materials and tools within normal grasp area to permit proper sequence of motions.
9. Development of gadgets of nominal cost to relieve body members of work.
10. Overlapping inspection time with physical motion time.
11. Reducing positioning time to a minimum.
12. Elimination of planning from productive work.

As an example of the *first* principle I would cite again the operation of a typewriter where it has been shown that by holding the elbows close to the sides the fastest body members are brought into use more frequently, thereby increasing the production of the operator with less fatigue.

The *second* principle, eliminating physical motion by rearranging sequence of work elements, can best be illustrated by describing a man working at a lathe *by the usual method:*

1. Stop machine.
2. Remove piece from machine.
3. Walk to truck and lay aside piece.
4. Walk to new piece.
5. Walk back to machine with new piece.
6. Place new piece in machine.
7. Start machine.

By rearrangement of work elements the improved method would be as follows:

1. Stop machine.
2. Remove piece from machine.

3. Place new piece in machine.
4. Start machine.
5. Walk to lay down piece on truck.
6. Walk to obtain new piece.
7. Walk back to machine.

It will be seen that the controlling time in this operation is the running of the machine; therefore any work done while the machine is in operation has no control over the quantity of production. Therefore, the inexperienced mind would immediately see the advantage of the rearrangement.

The *third* principle, that of utilizing both hands simultaneously for productive work, can best be illustrated by describing the operation of cementing baseball centers, as performed at a rubber company in Akron, Ohio. Under the old method, the left hand held half of a center while a brush in the right hand smeared it with cement. The new method consisted of each hand picking up a center, passing it over a screen covered with cement, and laying it aside to dry. By this change two centers are handled at the same time bringing about an increase in production of 100 per cent.

The *fourth* principle, that of eleminating "holds" and reducing the number of "grasps," can best be explained by giving the example of the inspection and gauging of rubber gaskets. This operation was also being performed at the same rubber company. Under the old method a girl would hold a number of gaskets in her left hand while her right hand would remove one from the left, inspect it with her eyes, and drop it through a gauge to make sure it was of the right size. Her left hand was holding at the same time while her right hand and eyes were moving over the work. Under the new method the gauge is fastened to the table, the left hand is reaching for a gasket while the right hand is turning a gasket for inspection and dropping it through the gauge. The eyes then inspect the gasket held in the left hand while the right reaches out for the next one. By performing the operation this way both hands are kept busy and the production of the operator has increase 50 per cent.

The *fifth* principle, prepositioning tools and materials to reduce "search and select," can best be described by the old axiom, "A place for everything and everything in its place." A very simple

illustration of this would be the orderly arrangement of tools and materials by types in separate compartments of a mechanic's tool box as compared with the tools thrown together in a bag or box.

The *sixth* principle, the use of release load in transit or drop delivery, can best be illustrated by the arrangement, used on many punch presses, of a jet of air used to clean out small metal stampings which then fall into a chute leading to a tote box. This jet of air might be applied either by the foot or hand. The use of the foot saves a good deal of time because while the foot in operating the air valve both hands are free to insert the next piece in the machine.

The *seventh* principle, the use of feet to relieve work of hands, has been included in the description of the sixth principle.

The *eighth* principle, the arrangement of materials and tools within normal grasp area to permit proper sequence of motions, can best be covered by an explanation. In the horizontal plane there is a definite area within which materials and tools should be placed so that they may be handled and the work performed with the normal expenditure of energy. The area for the right hand will be indicated by an arc drawn with the right arm fully extended in front making a clean sweep across the table pivoting from the shoulder. The area for the left hand is likewise indicated in the same manner. These two areas are termed the maximum working area beyond which it is only possible to use "fifth class motions," the least desirable classification. These two areas are again divided into two areas termed "normal working areas" which are indicated by arcs drawn in the same manner, but with the forearms only extended and with the elbows close to the body. These zones represent the most desirable areas in which to locate materials and tools.

The *ninth* principle, the development of gadgets of nominal cost to relieve body members of work, has been covered by practically all of the foregoing principles.

The *tenth* principle, overlapping inspection time with physical motion time, can be illustrated by the inspection and packing of innertubes. Certain brands of tubes are wiped with a cloth before being packed in a box. The tube is removed from a truck, inflated slightly to remove wrinkles, then laid flat on the table. The wiping and inspection of the tubes are performed simultaneously at this

point. The one operation can be performed as rapidly as the other so there is no idle time of the body members.

The *eleventh* principle is reducing positioning time to a minimum. Positioning is the act of placing one thing in an exact and prearranged relation to other things. The skill of many operations is in connection with positioning tools and materials used in the operation. The higher rewards paid in skilled operations is frequently due to skill in positioning. Nearly every factory operation requires positioning material in one or more ways. It is estimated that 10 per cent of all factory work consists of positioning. Much of this time can be reduced or eliminated by the developments of guides and stops. For example, I wish to cement the eraser of the pencil held in the left hand to the eraser of the pencil held in the right hand. By grasping a pencil in each hand and contacting the eraser of each with a cementing screen I am ready to position both ends together. This can be done rapidly by providing a simple guide. It can readily be seen that positioning time has been reduced materially by the use of a simple piece of wood.

The *twelfth* principle is the elimination of planning from productive work. Planning is defined as the act of determining a course of action and, of course, it is apparent to all of us that it should not be up to the operator to determine what the course of action should be. The coordinative work should always be done by the supervisor and it is definitely a supervisor's duty to plan as much as possible in advance for the coordination of efforts of the workers.

Attitude of Workers and Supervisors

Labors attitude toward the use of motion and time studies can best be shown by the attitude of our Chief Executive. At a press conference April 7, 1942, Mr. Roosevelt declared that he was against piece work and bonuses as a wage incentive. He had opposed them in peace times and he remained equally opposed to their extension during the war. He was sure, he said, that most people would produce all they could without incentive stimulation. Precisely a year and a day later the President declared in his hold-the-line executive order, that nothing in it "shall be construed" to prevent the War Labor Board and other agencies from "authorizing

reasonable adjustments of wages . . . . in case of . . . . wage incentives."

The incentives' immediate purpose, of course, is to induce, and reward in cash, workers' extra effort. It is based upon a standard of normal performance arrived at by motion and time study. The attitude and cooperation of supervision is also an important element in the application of this work. Best results are obtained where department heads take an active part in the work.

Heeding the call for a greater output of war materials has put greater emphasis on this phase of industrial engineering. How can a war manufacturing operation be performed better and at a faster rate? What will be the cost of production? When can delivery be made? Through the application of accepted techniques properly applied, the accountant and the industrial engineer can answer these questions. This joint effort can bring about a more universal acceptance of motion and time study principles.